

COLLISION AVOIDANCE THROUGH IMPROVED COMMUNICATION BETWEEN TRACTOR AND TRAILER

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ABSTRACT

On September 2, 1994, NHTSA issued a notice in the Federal Register* to promote a cooperative program which would foster the development, evaluation, and deployment of heavy vehicle intelligent communication and powering enhancement system(s). In response to this solicitation, Delco Electronics Corporation, on behalf of its potential project partners, submitted a proposal** detailing a collaborative, jointly governed venture between industry and Government to develop and evaluate heavy-duty technology vehicles using two-way communication between the tractor and the trailer.

The object of this cooperative agreement was to foster the development, evaluation, and deployment of intelligent communication and powering, also requiring the installation of several advanced electrical sub-systems on the trailers in order to properly exercise these communication and powering techniques between the tractor and trailer in the real world. Among the devices installed on the vehicles, of particular interest to the government agencies, were the Side Collision Warning System, Brake Stroke Indicator, Head-Up Display, and a Rear View Video Camera as collision avoidance devices.

A unique feature of this program was the in-fleet operational testing of the systems, using real truck drivers, who faced real driver problems and performance pressures. The drivers introduced a recordable "human factors" element into the evaluation system with regard to the safety and productivity value of many of the tested systems. If something bothered them, it got shutoff or broken.

*Federal Register/Vol. 59, No., 170/Fri. Sept 2, 1994/ Notices pp 45750-52

**The application to the Dept. of Transportation - National Highway Traffic Safety Administration (NHTSA) was submitted by NHTSA Truck Technology Demonstration Consortium on November 22, 1994

INTRODUCTION

The medium- and heavy-duty vehicle industry has a significant impact on the U.S. transportation system and plays a vital role in shaping the health of the Nation's economy. An estimated 423,153 firms, comprised of Fortune 500 companies, smaller private firms, and common and contract carriers, operate medium- to heavy-duty trucks. In 1996, these firms:

- employed 9.5 million people, 5.6 million of whom are drivers;
- operated 1.62 million combination-unit and 4.27 million single-units medium- and heavy-duty trucks;
- operated 4.1 million trailers; and
- drove 267 billion vehicle miles.*

The last decade has seen a tremendous growth in truck travel, an increase of 40 percent; however, during that same time period, the fatal crash involvement rate for medium- to heavy-duty trucks decreased by 35 percent. Whether or not truck safety is being adequately addressed has caused conflict between industry and safety advocacy groups. Although there is a general consensus as to the need for expanding and improving overall safety measures regarding truck maintenance, performance, and design, there is strong opposition to certain industry initiatives, such as the utilization of larger, heavier trucks to increase productivity levels.

Other industries, i.e., the defense, aerospace, and computer industries, are beginning to penetrate and target the commercial vehicle market with their own technological initiatives to address the safety and productivity issues currently facing the trucking industry. The interests of both private and public sectors are at stake, dictating the necessity for mutual involvement in addressing pertinent issues, i.e., safety, design, performance, productivity, and maintenance.

* Source, American Trucking Associations (1996 Data)

Heavy-duty truck combination vehicles have two distinct units--the tractor and the trailer. Both units are designed, developed, manufactured, and marketed independent of each other by either the tractor manufacturer (supplying the towing unit) or the trailer manufacturer (supplying the cargo space to move goods). However, both units, the tractor and trailer, when linked together at the fifth wheel of the power unit and the king-pin of the trailer, function as one complete system.

The U.S. trucking industry relies on the widespread application of the SAE J560 plug/receptacle, an electrical connector developed in the 1950s, to provide electrical current and power between the tractor and the trailer. It is atypical for trailers (unlike their tractor counterparts) to have an independent electrical power source, such as a battery. Therefore, power and control are supplied from the tractor, via the seven-pin connector, to the trailer's running lights. This electrical connector provides six electrical circuits and one ground for vehicle powering and communications:

- **pin one** is used as a common ground for the six other positive power pins;
- **pin two** is used to power clearance and side marker lamps;
- **pin three** is used to power the left hand turn signal and hazard signal;
- **pin four** is used to power the stoplamp;
- **pin five** is used to power the right hand turn signal and hazard signal;
- **pin six** is used to power the taillamp, marker lamps, and license plate lamps; and
- **pin seven** is an auxiliary circuit that is available in most vehicle combinations. *

Unfortunately, technological growth and advancement have been hampered by the limitations of the standard six-circuit connection. Any changes to this connector may result in a lack of compatibility between the tractor and trailer units, particularly multi-unit vehicles, which are sensitive to the inherent constraints associated with vehicle powering and communication. New technologies frequently do not provide adequate power to trailer-based systems and do not have the capacity to transmit signals back to the tractor. Consequently, the current application of developing technologies has been limited to single unit trucks and truck tractors.

* TMC and SAE have recently changed the function of Pin Seven - Switched and shared power for ABS.

The multi-unit combination vehicle will likely play an instrumental role in improving the productivity of the trucking industry. The industry must move forward to eliminate constraints that limit the effectiveness of applying and integrating both existing and newly developed technologies for the trailer. Listed below are several technologies which are being envisioned for the application of, and in some cases, have already been installed on trucks and tractor systems.

Technologies which promote Operational Efficiency Benefits:

- vehicle/unit locators
- vehicle/driver trip loggers
- on-board weight measurement and recording systems
- vehicle maintenance status monitor/recorder/transmitters
- administrative credentials transponders

Technologies which promote Operational Safety Performance:

- sideward-looking, rearward-looking, and forward-looking collision avoidance systems
- driver performance monitors
- antilock and electronic braking systems
- brake maintenance status monitors, etc.

Tractor and trailer electrical systems will need to function as a combined unit to fully realize the safety, efficiency, and productivity potentials of these emerging technologies. Data generated by these sensing, processing, and signaling systems will be invaluable to the industry-wide operations of heavy-duty truck trailers.

Government

Rapid advancements in technology and its expansion into the U.S. transportation system have made it imperative for Government and industry to work together. Cooperation between Government and industry is necessary for fostering the developmental efforts of critical technological systems. Although, the industry is ultimately responsible for designing, manufacturing, marketing and implementing technology, it is the Government, i.e., the National Highway Traffic Safety Administration (NHTSA) and Federal Highway Administration (FHWA), through its research and regulatory efforts, which plays an instrumental role in the developmental process.

The Government serves in the following capacities:

- Identifies potential safety problems and opportunities and defines functional and performance targets for system improvements, that, if met by product designers, will maximize safety benefits.
- Develops research tools and databases for use by both industry and Government to provide fundamental driver/vehicle performance data needed by the private sector designers of collision avoidance, crashworthiness, and occupant protection systems.
- Performs tests and evaluations of generic product groups designed for a specific function or purpose.
- Works cooperatively with industry groups (e.g., manufacturers, suppliers, and truck users) to assess performance, reliability, maintainability, failure modes/consequences, and costs. Validation of safety performance specifications under real-world operating conditions will facilitate the deployment of marketable systems.
- Facilitates the early development of effective, cost-beneficial, and user friendly collision avoidance, crashworthiness, and truck occupant protection systems, especially in cases where corporate proprietary interests would normally preclude broad-based research efforts.

NHTSA is responsible for devising strategies that not only prevent, but also reduce, the number and severity of motor vehicle collisions on U.S. highways. More specifically, NHTSA's objective is to minimize the potential for personal injuries and property damage, and ultimately, to save lives.

NHTSA's **Office of Crash Avoidance Research** conducts and manages research intended to analyze driver-vehicle interaction; identify specific vehicle designs, components, or parameters associated with driver performance errors and resulting collisions; and develop and evaluate vehicle-based collision avoidance countermeasure concepts and devices. In order to meet these research objectives, NHTSA uses a variety of experimental techniques and analytical approaches:

- Analytical modeling
- Controlled laboratory experiments
- Controlled tests on test tracks or closed test courses

- Controlled tests conducted in real traffic
- Instrumented-vehicle field studies

FHWA's Office of Motor Carriers (OMC) is moving toward a new era of highway safety: the final destination, a "crash-free" environment. OMC will place emphasis on the fact that highway safety is EVERYONES' responsibility; all actions and reactions make an impact!

The OMC mission is to promote safe commercial vehicle operations through the development, communication, and enforcement of effective and cost-beneficial safety regulations and practices, and to promote technological and operational advances that support an efficient and economical transportation system. The agency's safety programs have been designed to meet the following goals and objectives as it moves into the twenty-first century:

1. Reduce the number of commercial motor vehicles crashes;
2. Build partnerships to improve motor carrier safety and performance; and
3. Identify and promote new technologies and strategies to enhance safety performance and productivity.

COOPERATIVE RESEARCH PROGRAMS

The cooperative research programs enable both the Federal Government and industry to pool their collective resources and work towards the improvement and advancement of the U.S. transportation system. Results from these research studies are used in published research papers and technical reports, and they form the basis for Federal Motor Vehicle Safety Standards (FMVSS)*. NHTSA/FHWA-sponsored research has also been used in the formulation of many industry Standards/Recommended Practices (RPs) through the auspices of the Society of Automotive Engineers (SAE) International and the Maintenance Council (TMC).

In these cooperative agreements, the Government is dependent upon the active participation and cooperation of the industry to provide the necessary vehicles, equipment, and personnel to effectively conduct, evaluate, and meet its

* NHTSA develops and publishes FMVSS as part of its overall highway and motor vehicle safety program. These standards specify safety performance requirements for complete vehicles and vehicle components (e.g., brake systems and occupant restraint systems). They apply to manufacturers of motor vehicles and suppliers of equipment for motor vehicles (e.g., tire, brake hose and lighting equipment manufactures) who offer their products for sale in the U.S. (Heavy Vehicle Safety Research: A New Agenda for the 21st, Page 37).

research objectives. Ultimately, the industry reacts to, debates, or implements the issues, findings, or solutions put forth by the Government's research efforts. NHTSA and FHWA, along with the mutual support of other Government agencies and industry organizations, strive to develop non-overlapping, synergistic research and regulatory efforts. It is the agencies' goal to facilitate industry-wide consensus and the voluntary implementation of performance, design, and safety standards. These measures will ultimately impact both the public and commercial sectors thereby preparing the U.S. transportation system for the twenty-first century.

TECHNOLOGY DEMONSTRATOR PROJECT

On September 2, 1994, NHTSA issued a notice in the Federal Register* to promote a cooperative program which would foster the development, evaluation, and deployment of heavy vehicle intelligent communication and powering enhancement system(s). In response to this solicitation, Delco Electronics Corporation, on behalf of its potential project partners, submitted a proposal** detailing a collaborative, jointly governed venture between industry and Government to develop and evaluate heavy-duty technology vehicles using two-way communication between the tractor and the trailer.

The following connectors were supplied by the industry to test the powering and communication systems between the two tractors and trailers used in this project, testing the following connectors—Cole Hersee (13-Pin/J560); 3731 ISO Modified Connector; Infrared Connector; and three (3) Power Line Carriers.

COLLISION AVOIDANCE DEVICES

The object of this cooperative agreement was to foster the development, evaluation, and deployment of intelligent communication and powering systems on heavy duty vehicles. The ability to effectively demonstrate various communication and powering techniques required the installation of several advanced electrical sub-systems on the trailers in order to properly exercise these communication and powering techniques. Among the 30 devices installed, of particular interest to the government agencies, was the Side Collision

Warning System, Brake Stroke Indicator, Head-Up Display, and a Rear View Video Camera as collision avoidance devices.

A unique feature of this program was the in-fleet operational testing of the systems, using real truck drivers, who faced real driver problems and performance pressures. The drivers introduced a recordable "human factors" element into the evaluation system with regard to the safety and productivity value of many of the tested systems. If something bothered them, it got shutoff or broken.

The Side Collision Warning feature worked continuously with a small light in the upper portion of the rear view mirror. An audible buzzer warning sounded if the turn signal was on. The signal transmission was in the form of power-line carrier, meaning the signal was transferred over a power line (in this case, the auxiliary circuit). The drivers' reaction was very positive. They used the device to enhance their driving capability. They still relied on their mirrors before making any final decision. Maintenance records did not indicate any problem. A minor problem did occur when the Side Collision Warning device set-off the police radar detector in Tennessee. We had to arm the drivers with a letter stating this was not a radar detector device.

The Head Up Display was useful to the driver in that information such as vehicle speed, engine RPMs, engine temperature, brake stroke indicator, ABS malfunction indicator, and the rear view video were available to the driver without having to search down on the dash-board. In other words, the driver could keep his eye on the road in front of him. One driver showed a police officer how he kept track of his speed on the Head Up Display and was not given a speeding ticket for which he was stopped.

The Brake Stroke Indicator used a magnetic field to electronically measure the brake stroke travel and notified the driver by means of a red light as the travel approached pre-set conditions. Drivers found this device useful and in a demonstration project, the truck's home office was notified of the brake stroke travel on a particular unit using the Qualcomm communications system in real time. In order to use as many communication systems as possible, the Brake Stroke Indicator feature used the infrared connector and the Side Collision Warning feature used a form of power line carrier to communicate information to the cab.

The Rear View Video Camera displayed a picture to the driver of what was behind him, using the Head-Up Display. This feature was very useful in the Domino's Pizza unit because of the nature of their deliveries. Because of the low

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power range in which the video signal operated, problems with corrosion in the connector were very evident. Also the signal was very susceptible to electromagnetic interference. Drivers wanted the picture reversed to appear as if they were looking in a rear view mirror.

The following table shows core members, service or product contributions, and product attributes.

This is followed by a brief critique of the cooperative agreement.

**NHTSA TECHNOLOGY DEMONSTRATOR CONSORTIUM.....
CORE MEMBERS, SERVICE & PRODUCT CONTRIBUTIONS, AND PRODUCT ATTRIBUTES**

COMPANY NAME	SERVICES	PRODUCTS	PRODUCT ATTRIBUTES POSITIVE	PRODUCT ATTRIBUTES NEGATIVE
Delco Electronics Core Member	<ul style="list-style-type: none"> • Project Coordinator and Management • Liaison between Consortium and Government (i.e. NHTSA) 	<ul style="list-style-type: none"> ■ Data Vision HUD (Head-Up-Display). Displays oil pressure; speed; engine RPM; Boost Pressure, etc. <p><i>[Refer to Figure 11 & 19 under Photographs]</i></p> <ul style="list-style-type: none"> • Forewarn Collision Warning System for tractor and trailer 	<ul style="list-style-type: none"> • All drivers like to use the Head-Up-Display and the Collision Warning System. • Interface to video camera is also considered a great feature. 	<ul style="list-style-type: none"> • A failure of the collision warning system occurred to the Wabash trailer. The SDS (side detection system) experienced interference from police radar detector.
Freightliner Core Member	<ul style="list-style-type: none"> ■ Tractor paired with Wabash Trailer ■ Leased to Certified Transports, Seattle, WA 	<ul style="list-style-type: none"> • Tractor Model # FLD-120 <p><i>[Refer to Figure 2, 10, 11, 12, 13, 18 & 19 under Photographs]</i></p>		
Ryder Transportation Services Core Member	<ul style="list-style-type: none"> • Leasing services to Certified Transports, Seattle, WA • Leasing services to Domino's Pizza • Field Support/Data Collection 	<ul style="list-style-type: none"> • Mileage - Field Operations 		
Vehicle Enhancement Systems, Inc. Core Member	<ul style="list-style-type: none"> • Installation of Technologies on two Tech Demo vehicles. • Technical Support • Field Service Support and Repair • Final Report 	<ul style="list-style-type: none"> • Infrared Gladhand-SAE J1708/1587 data communications between tractor and trailer <p><i>[Refer to Figure 4 & 9 under Photographs]</i></p>	<p>Connection worked well</p>	<ul style="list-style-type: none"> • Infrared gladhand on Utility trailer would intermittently contaminate and pull down the SAE J1708/1587 buss on the Volvo Tractor. Has been temporarily removed.

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COMPANY NAME	SERVICES	PRODUCTS	PRODUCT ATTRIBUTES POSITIVE	PRODUCT ATTRIBUTES NEGATIVE
Volvo Core Member	<ul style="list-style-type: none"> Tractor paired with Utility Trailer equipped with Thermo King Reefer <p><i>[Refer to Figure 1 under Photographs]</i></p> <ul style="list-style-type: none"> Technical support Leased to Domino's Pizza, Nashville, TN 	<ul style="list-style-type: none"> Tractor V/N (model) Conventional Electronic Engine 		<ul style="list-style-type: none"> Electronic engine problem with software package used for driver management (CADEC System)
NHTSA/FHWA Core Member	<ul style="list-style-type: none"> Project Director Funding Technical Guidance and support Coordinated and supported Navy connector testing 	<ul style="list-style-type: none"> Provided independent evaluation of connectors 		
Air Weigh	<ul style="list-style-type: none"> Technical assistance 	<p>F. Electronic Weigh System</p> <p><i>[Refer to Figure 2 under Photographs]</i></p>	<p>G. Real time weight of trailer and tractor rear axles. Interfaces with Satellite communications</p>	<ul style="list-style-type: none"> System presently available only on Air Suspension Vehicles.
Allied Signal Truck Brake Systems	<p>G. Technical assistance</p>	<ul style="list-style-type: none"> ABS System (Volvo Tractor) <p><i>[Refer to Figure 1 under Photographs]</i></p>	<ul style="list-style-type: none"> No problems found during tests (70,000 miles and 150,000 miles) 	
American Trucking Association, Inc. (ATA)	<p>10. Technical assistance</p> <p>11. Project assistance: Powering and communications between tractor and trailer(s)</p>			

NHTSA TECHNOLOGY DEMONSTRATOR CONSORTIUM.....

CORE MEMBERS, SERVICE & PRODUCT CONTRIBUTIONS, AND PRODUCT ATTRIBUTES

COMPANY NAME	SERVICES	PRODUCTS	PRODUCT ATTRIBUTES POSITIVE	PRODUCT ATTRIBUTES NEGATIVE
Certified Transport	<ul style="list-style-type: none"> 8. Fleet Service Application 9. Leased Freightliner/Wabash Unit <p><i>[Refer to Figure 2 under Photographs]</i></p>	<ul style="list-style-type: none"> ■ 13-Pin Connector ■ ISO 3731 Connector (Freightliner/Wabash) <p><i>[Refer to Figure 3.9 & 23 under Photographs]</i></p>	<ul style="list-style-type: none"> ■ Allows six (6) extra circuits within the SAE J560 Connector 	<ul style="list-style-type: none"> ■ Corrosion problems with the terminals in the plug. Plug has separated once on each vehicle ■ Availability of parts in the field limited. ■ Data communications and low current devices, such as LED lamps appear to work intermittently once corrosion occurs.
Dearborn Group	<ul style="list-style-type: none"> ■ Technical Support 	<ul style="list-style-type: none"> ■ Chatter Boxes - broadcast SAE J1708/1587 and J1939 	<ul style="list-style-type: none"> ■ Device will only test tractor/trailer communications with SAE J1587 and SAE J1939 ■ Data can be broadcasted to Qualcomm Satellite Communications 	<ul style="list-style-type: none"> ■ Trailer (s) may not need SAE J1939
Delco Remy America	<ul style="list-style-type: none"> ■ Technical Support 	<ul style="list-style-type: none"> ■ Smart Alternator (Freightliner) 	<ul style="list-style-type: none"> ■ Capable of broadcasting alternator status to Head-Up Display/Satellite Communications 	
Domino's Pizza	<ul style="list-style-type: none"> ■ Fleet Service Applications ■ Leased Volvo/Utility Unit <p><i>[Refer to Figure 1 & 2 under Photographs]</i></p>			
Goodyear Tire & Rubber	<ul style="list-style-type: none"> ■ Tire Installations 	<ul style="list-style-type: none"> ■ Tires (tractor & trailer) <p><i>[Refer to Figure 1 & 2 under Photographs]</i></p>		
Graphiclite Systems		<ul style="list-style-type: none"> ■ Lamps for exterior trailer wall illumination (Utility) 	<ul style="list-style-type: none"> ■ Better conspicuity of trailer (night driving) 	<ul style="list-style-type: none"> ■ Lamps protrusion exceeds 102" width of trailer

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CORE MEMBERS, SERVICE & PRODUCT CONTRIBUTIONS, AND PRODUCT ATTRIBUTES

COMPANY NAME	SERVICES	PRODUCTS	PRODUCT ATTRIBUTES POSITIVE	PRODUCT ATTRIBUTES NEGATIVE
MGM Brakes	<ul style="list-style-type: none"> ■ Technical support and installations 	<ul style="list-style-type: none"> ■ Brake chambers ■ Electric Stroke Alert technology 	<ul style="list-style-type: none"> ■ Electronically indicates over stroke and dragging brake problems ■ Information is displayed on Head-Up Display/Satellite Communications ■ Detected dragging brake conditions on Freightliner/Wabash vehicle 	<ul style="list-style-type: none"> ■ Several connector problems with wires at brake chamber
Midland-Grau Heavy Duty Systems	<ul style="list-style-type: none"> ■ Technical support 	<ul style="list-style-type: none"> ■ Trailer ABS systems 	<ul style="list-style-type: none"> ■ Diagnostic codes on ECU helpful 	<ul style="list-style-type: none"> ■ Trailer LED (light Emitting Diode) warning lamp would not function with ABS system. Additional resistive load on the lamp warning circuit had to be added for system to function
Moto-Mirror	<ul style="list-style-type: none"> ■ Technical support 	<ul style="list-style-type: none"> ■ Motorized passenger side mirrors which incorporate Collision warning lamps <p style="margin-left: 20px;"><i>[Refer to Figure 13 under Photographs]</i></p>	<ul style="list-style-type: none"> ■ Driver is forced to look at mirror in order to get collision warning system 	<ul style="list-style-type: none"> ■ One driver used warning system without using the mirror
Pressure Systems International	<ul style="list-style-type: none"> ■ Technical support and installation 	<ul style="list-style-type: none"> ■ Automatic Tire Inflation Systems 	<ul style="list-style-type: none"> ■ Automatically keeps tires inflated to proper pressure levels ■ Several flats were fixed at drivers convenience ■ Very favorable response from drivers 	<ul style="list-style-type: none"> ■ No problems found
Purkey's Fleet Electrics	<ul style="list-style-type: none"> ■ Technical support and installation 	<ul style="list-style-type: none"> ■ Battery Management Systems 	<ul style="list-style-type: none"> ■ Automatically saves batteries for cranking. [e.g. refrigerator left on, (Freightliner) vehicle started right away] 	<ul style="list-style-type: none"> ■ No problems found
Qualcomm	<ul style="list-style-type: none"> ■ Technical support 	<ul style="list-style-type: none"> ■ Satellite systems 	<ul style="list-style-type: none"> ■ Locates vehicles, interfaces tractor and trailer data to home base ■ Very reliable 	<ul style="list-style-type: none"> ■ No problems found
Raychem	<ul style="list-style-type: none"> ■ Technical Support 	<ul style="list-style-type: none"> ■ SAE J1939 physical layer cable for tractors and trailers 	<ul style="list-style-type: none"> ■ Twisted-pair wire with shield required to protect signal from outside electrical interference 	<ul style="list-style-type: none"> ■ Twisted-pair wires with shield extremely hard to install on tractor and trailer already built

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CORE MEMBERS, SERVICE & PRODUCT CONTRIBUTIONS, AND PRODUCT ATTRIBUTES

COMPANY NAME	SERVICES	PRODUCTS	PRODUCT ATTRIBUTES POSITIVE	PRODUCT ATTRIBUTES NEGATIVE
Sure Power Industries		<ul style="list-style-type: none"> ■ Power Booster Module (Freightliner) 	<ul style="list-style-type: none"> ■ Added to ensure proper voltage in trailer 	<ul style="list-style-type: none"> ■ Power line carrier data was attenuated in the power booster
Thermo King Corp.	<ul style="list-style-type: none"> ■ Technical consulting services regarding communication capabilities 	<ul style="list-style-type: none"> ■ Smart Reefer unit 		
Tramec	<ul style="list-style-type: none"> ■ Technical support 	<ul style="list-style-type: none"> ■ Delay stop lamp switch (Volvo) 	<ul style="list-style-type: none"> ■ Delayed stop lamp power allows trailer ABS system to remain on during pumping of brakes (if constant power not used) 	<ul style="list-style-type: none"> ■ Prototype switch failed after six months of use
Truck-Lite	<ul style="list-style-type: none"> ■ Technical support and installations 	<ul style="list-style-type: none"> ■ Power Line Carrier (PLC) Spread Spectrum technology for ABS trailer warning ■ Smart-Lite™ Technology ■ Smart-Plex™ Technology <p><i>[Refer to Figure 5, 7, 10, 11, 12, 14, 15, 16, 17 & 18 under Photographs]</i></p>	<ul style="list-style-type: none"> ■ Appears to be immune to connector terminal corrosion problems ■ Appears to be compatible with other communication systems using power line carrier technologies such as Qualcomm's trailer ID system and Air Weigh. All three (3) systems function together on the Freightliner/Wabash combination 	<ul style="list-style-type: none"> ■ Prototype transceiver chips susceptible to attenuation of other electronic modules on trailer
Utiler Trailer Manufacturing Co.	<ul style="list-style-type: none"> ■ Technical support 	<ul style="list-style-type: none"> ■ Reefer trailer. Used with Volvo tractor <p><i>[Refer to Figure 2, 3, 4, 5, 6, 7, 8, 9, 15, 16, 17, 20 & 22 under Photographs]</i></p>		
Wabash National	<ul style="list-style-type: none"> ■ Technical support 	<ul style="list-style-type: none"> ■ Trailer. Used with Freightliner tractor 		
Weldon	<ul style="list-style-type: none"> ■ Technical support 	<ul style="list-style-type: none"> ■ High energy strobe system (Utility) 	<ul style="list-style-type: none"> ■ Solid state, high output strobe energized during backing 	<ul style="list-style-type: none"> ■ Several systems were affected by the high-energy strobe system such as video interference on the rear camera ■ The strobe affected the Smart-Plex system, until a better ground was implemented on the strobe

COOPERATIVE AGREEMENTS BETWEEN INDUSTRY & GOVERNMENT...A CRITIQUE:

In critiquing the industry/Government cooperative agreements, several factors have to be considered:

1. In getting (in this case) 30 independent companies/agencies to work together, extremely long delays can be encountered while the lawyers determine if the individual companies can agree to participate.
2. A core group has to be formed to provide the leadership necessary to advance the project.
 - A. In this case, a core group of seven companies/agencies (NHTSA and FHWA) formed the core group.
 - B. One company must provide the overall leadership (i.e., handling administration, signing contracts, etc.)
 - C. There needs to be rules for accepting other members into the project.
 - D. The project grew from 7 to 30 members. Rules established included:
 1. Only core members could vote.
 2. Acceptance of other members was based on what they had to offer the project.
 3. Ability to work with core members.
 - E. To be realistic, vehicles should be placed in revenue-producing service.
3. The Group was able to identify strengths and weaknesses of some 30 items.
4. Driver input was limited.
 - A. Written reports from drivers were poor.
 - B. Oral reports were good.
5. Management reports were good.
6. The project forced industries that do not normally associate with one another to work together for successful completion of the project. Each member got a better understanding of how other industries worked.
7. Data collection from vehicles operating in the field has always been a problem.
 - A. Able to collect data in real time using Qualcomm
 - B. Because of delays in getting vehicles on the road and not being sure of what each vehicle would have in terms of technology, it was difficult to develop a data collection plan or collect data since information had to be programmed so that the Qualcomm System would understand, what was being sent.
8. New driver indoctrination was poor. The driver was usually given a few minutes briefing before being turned loose.
 - A. More time is needed in order to have things properly explained.
 - B. Drivers felt that they were special and, therefore, they may have driven differently than normal.
 - C. A means must be developed to verify drivers' reactions (driver may not realize what he is doing).
9. The core and supporting members exceeded the demands placed on them. Everybody wanted the project to work, especially the truck fleet management and leasing companies.
10. The ease with which The Qualcomm system provided data, in almost real time, has and will open new methods of data collection for in-fleet operational data collection efforts.

PHOTOGRAPHS



Figure 1. Technology Demonstration Vehicle #2 operated by Domino's Pizza of Nashville, TN.

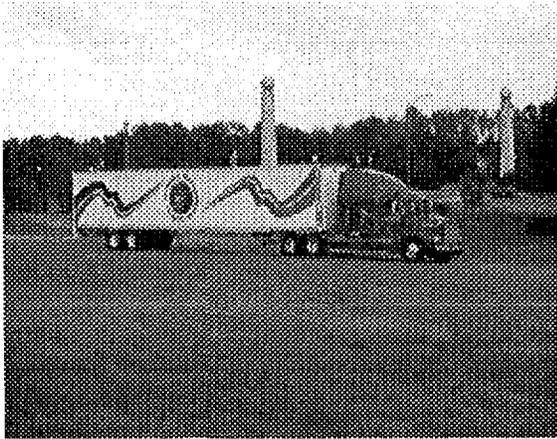


Figure 2. Technology Demonstration Vehicle #1 operated by Certified Transport of Seattle, WA.

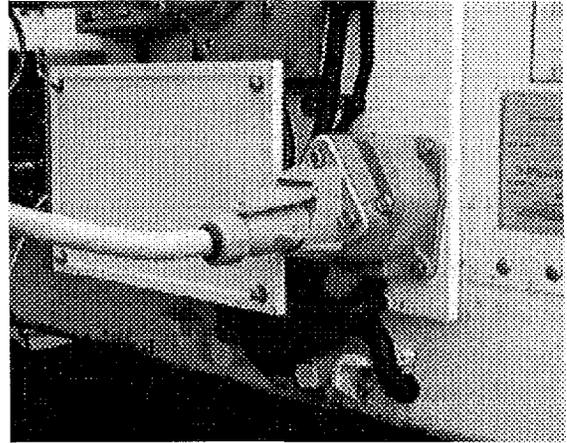


Figure 3. Wabash Trailer: Cole Hersee 13-Pin Connector is used for SAE J1939 (3 pins) and Video RS170 (2 pins) with Power Line Carrier Communications on Aux. Pin 7.

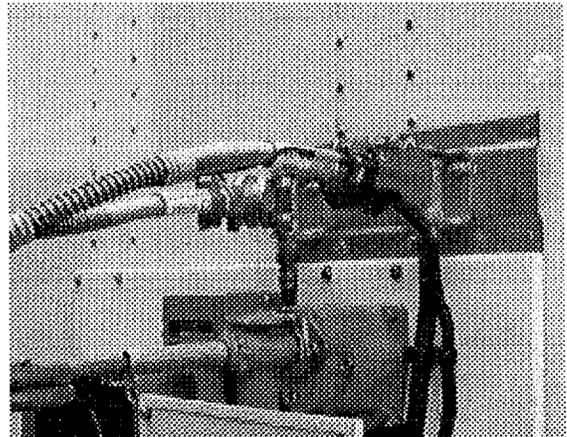


Figure 4. Wabash Trailer: ISO Connector 3731 and SAE J318 Emergency gladhand with SAE J1708/1587 Bridge. The ISO Connector is wire for SAE J1708/1587 and ABS Constant Power.

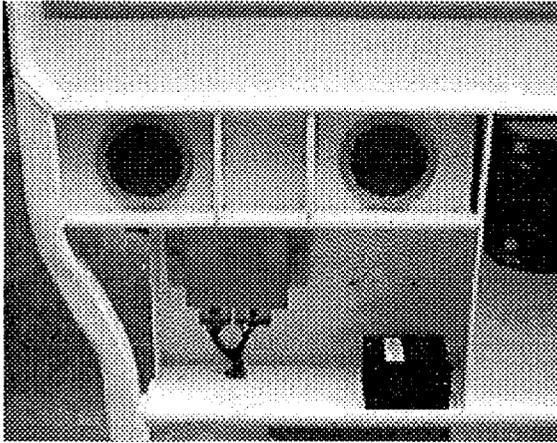


Figure 5. Wabash Trailer: Left Rear—the Truck-Lite Smart Power Line Carrier Technology Box controls the backup lamps, Backup Alarm, Internal Dome Lamps, ABS Warning, Low Air pressure, and Brake Warning.

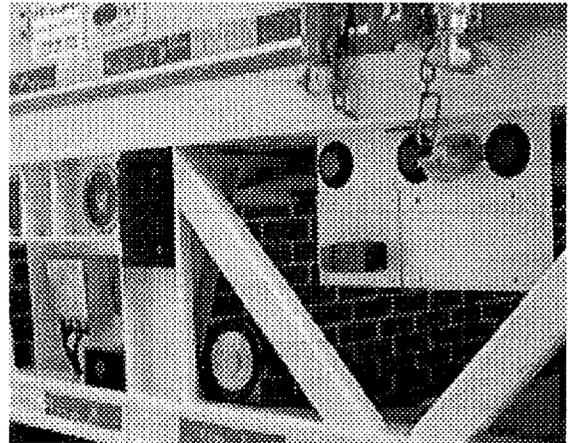


Figure 7. Wabash Trailer: Left Rear—The Truck-Lite Smart Power Line Carrier Technology box controlling the Backup Alarm—Bottom Left Rear. Right Rear—Video/Lamp Camera, Center Rear—Backup Lamps controlled by the Truck-Lite Power Line Carrier box.

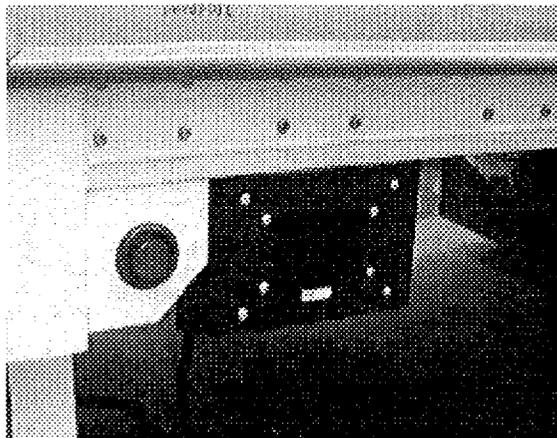


Figure 6. Wabash Trailer: Delco Electronics Radar Collision Warning Side Detection System. Power Line Carrier Communication is the method for tractor/trailer communication.

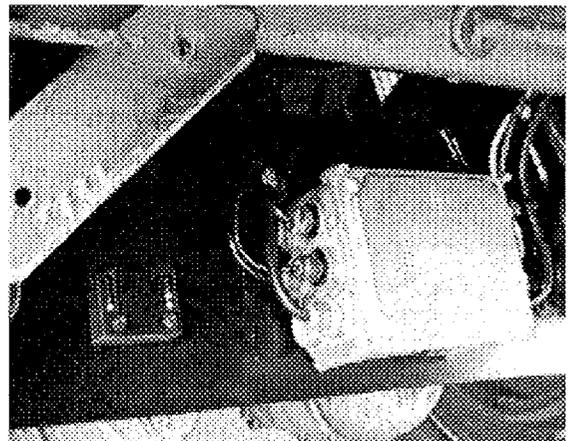


Figure 8. Wabash Trailer: Midland-Grau ABS and Airweight System. Midland-Grau system uses SAE J1708/1587 Communications while the air weigh system uses the Power Line Carrier System over the turn signal circuits of the SAE J560 electrical connector.

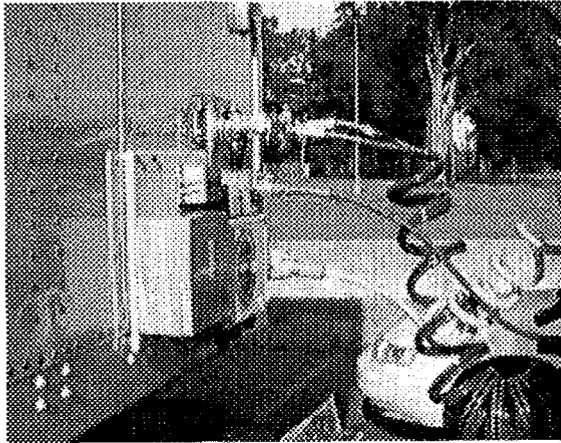


Figure 9. Wabash Trailer: Front nose–Junction Box, Qualcomm Trailer ID Module ISO Connector 3731, SAE J310 Emergency gladhand with infrared SAE J1708/1587 Bridge, Cole Hersee 13-Pin connector.



Figure 11. Freightliner Tractor: Head-Up Display Combined with Engine RPM, Vehicle Speed, Engine Oil Pressure, Water Temperature, and Tractor/Trailer Brake Stroke Warning System–All Driven by SAE J1708/1587 Data Bus.

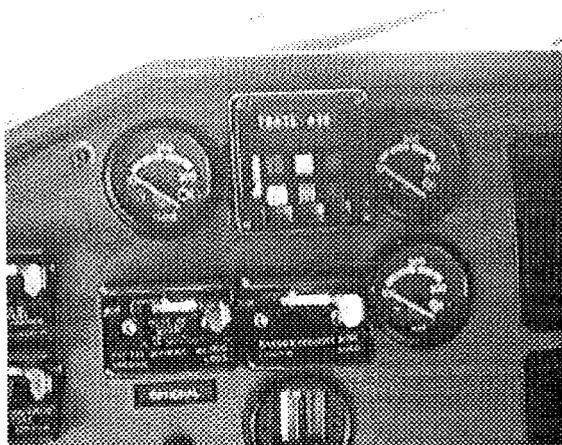


Figure 10. Freightliner Tractor: Truck-Lite Smart Technology display. Display is showing low air brake status from the trailer. The communication technology is Power Line Carrier, which uses existing power lines on the Tractor/Trailer.

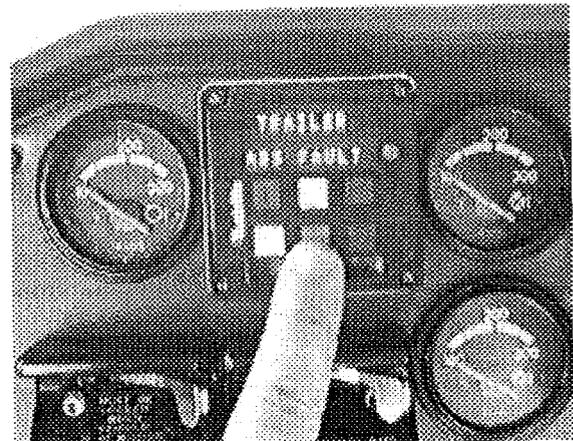


Figure 12. Freightliner Tractor: truck-Lite Smart Technology Display. Display is showing trailer ABS fault warning on the tractor dash. The communication technology is Power Line Carrier, which uses existing power lines.

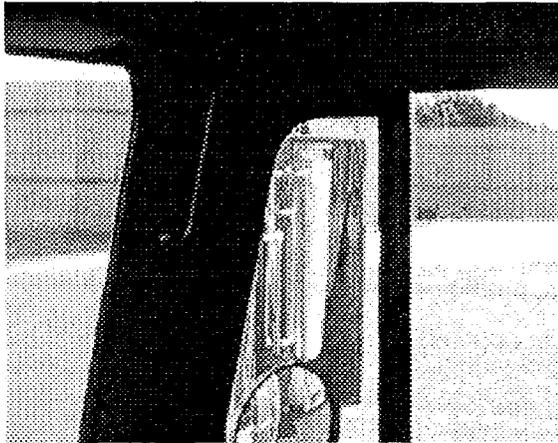


Figure 13. Freightliner Tractor with Delco Electronic Side Detection System Warning mounted in Passenger side mirror system.



Figure 15. Wabash Trailer: Led (Light Emitting Diode Lamps) installed on the side of the trailer.

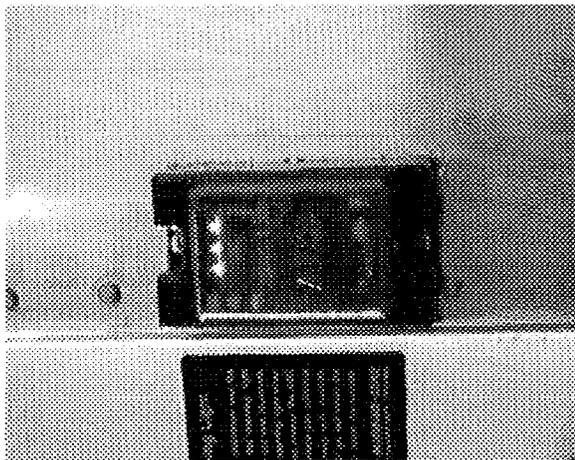


Figure 14. Freightliner Tractor: MGM Electronic Stroke alert module communicating SAEJ1708/1587 with Visible led warning.

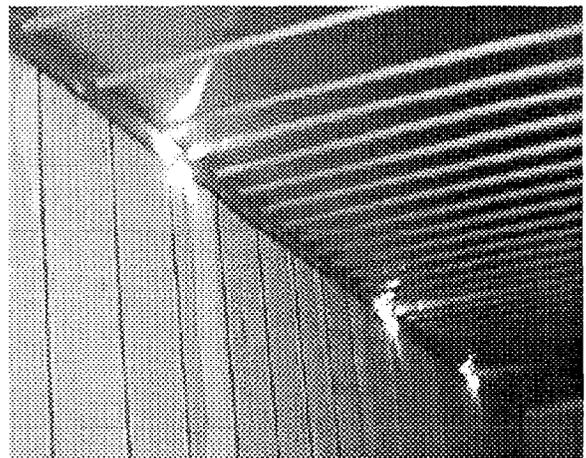


Figure 16. Wabash Trailer: Dome Lamps controlled by the Truck-Lite Smart Technology control box (power-line carrier communication technology).

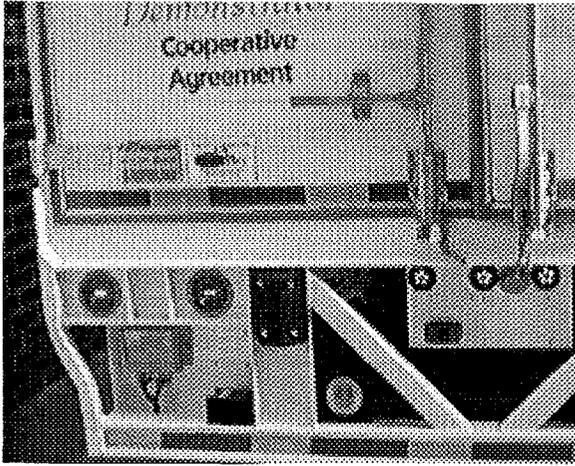


Figure 17. Wabash Trailer: Left Rear–The Truck-Lite Smart Power Line Carrier Technology Box.

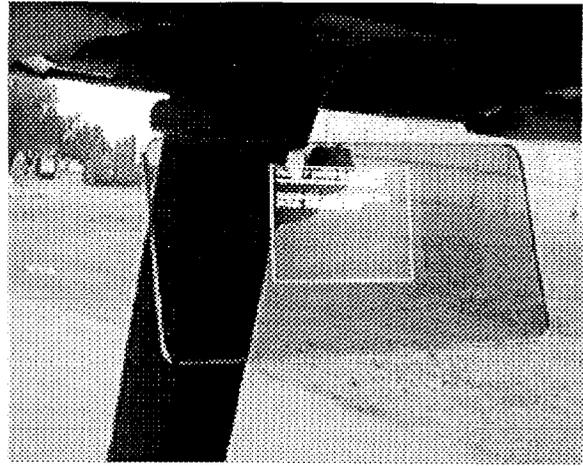


Figure 19. Freightliner Tractor: Head Up Display combined with text messages from SAE J1708/1587 Data Bus. Messages describe brake chamber status.

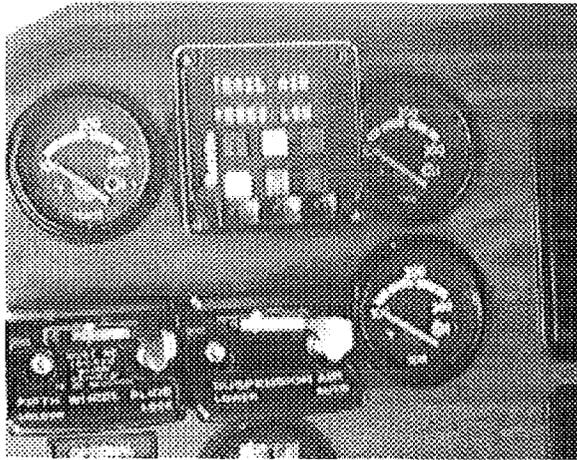


Figure 18. Freightliner Tractor: Truck-Lite Smart Technology Display. Display is showing low air brake status from the trailer the communication technology is Power Line Carrier.



Figure 20. Camera not working (corrosion in J560)

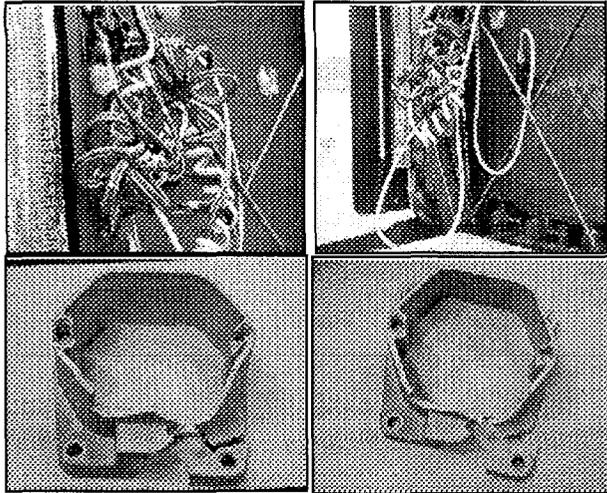


Figure 21. ISO 3731 cable not coiled. Caused receptacle box to break.

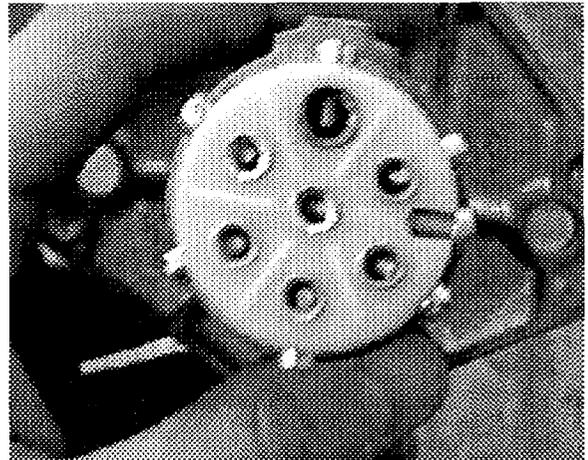


Figure 23. The ISO3731 receptacle suffered a broken wire termination screw during initial installation. A new connector was installed in its place.

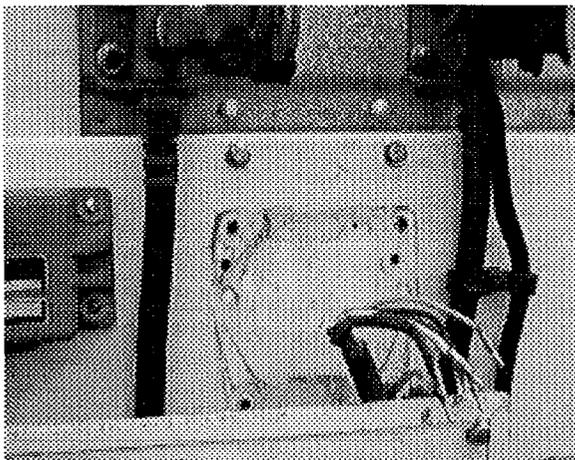


Figure 22. ISO3731 receptacle Broken (cable snagged on Tractor).

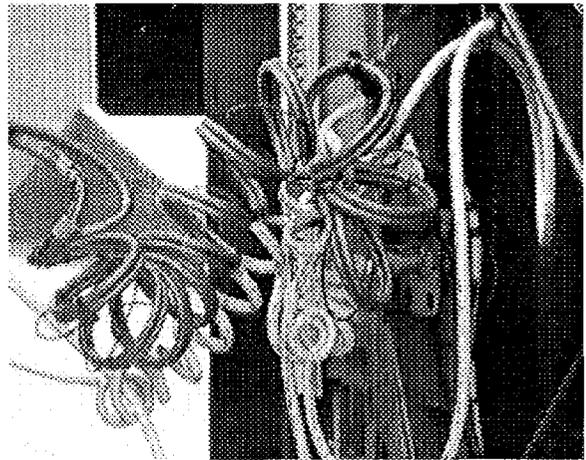


Figure 24. The combination of electrical cords and pneumatic hoses creates a tangle at the back of the Freightliner tractor.

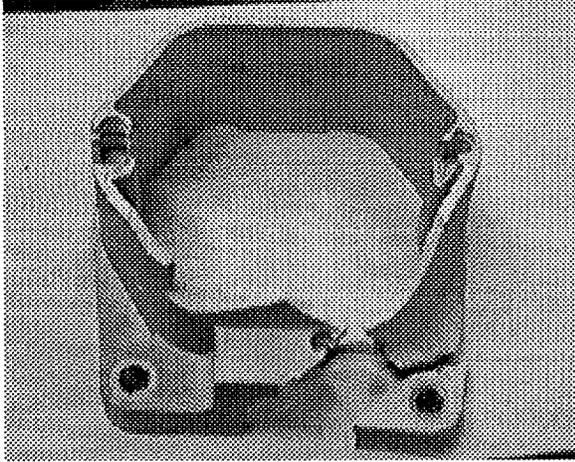


Figure 25. The ISO3731 connector mounting box at the front of the Wabash trailer was broken during a tight turning maneuver. The cable was caught on the deck plate and pulled the receptacle from the trailer.